APPRENTICESHIP TRAINING

Electrician Program

Alberta
ADVANCED EDUCATION
Apprenticeship and Industry Training

ISSN 1712-5731

Electrician

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Course Outline

Apprenticeship and Industry Training System

Apprenticeship is post-secondary education with a difference. It helps ensure Alberta has a steady supply of highly skilled employees, the foundation of our economy's future health and competitiveness.

Apprentices in more than 50 trades and crafts spend between one and four years learning their trade - 80% of the time on the job under the supervision of a certified journeyman or qualified tradesperson. The balance of the program is technical training in the theory, skills and technologies of their trade.

To become certified journeymen apprentices must learn theory and skills, and they must pass examinations. Requirements for certification—including the content and delivery of technical training—are developed and updated by the Alberta Apprenticeship and Industry Training Board (the Board) and a network of local and provincial industry committees.

The graduate of the Electrician apprenticeship training is a journeyman who will be able:

- have a through knowledge and understanding of electrical theory and its application to lighting, power and control equipment.
- layout and install the various electrical circuits in residential, commercial, industrial and institutional complexes and buildings.
- implement the instructions given in plans and specifications pertaining to electrical installations.
- be thoroughly familiar with the safety requirements for electrical installations.
- be capable of trouble shooting and maintaining electrical systems and equipment.
- competently use the test instruments and various tools necessary to perform tasks.
- be familiar with the work of other tradesmen in the construction industry and with the different types of building construction.

Apprenticeship and Industry Training Committee Structure

While government supports Alberta's apprenticeship and industry training system, it is driven by industry, a term which includes both employers and employees. The Alberta Apprenticeship and Industry Training Board, with the support of Alberta Learning, oversees the system. But the system relies on a network of industry committees. These committees include local and provincial apprenticeship committees (LACs and PACs) in the designated trades and occupational committees (OCs) in the designated occupations, as well as other committees such as provisional committees established before the designation of a new trade or occupation comes into effect. All these committees are composed of equal numbers of employers and employees. The network of industry committees is the foundation of Alberta's apprenticeship and industry training system.

Local Apprenticeship Committees (LAC)

Wherever there is activity in a trade, the Board can set up a LAC. The Board appoints equal numbers of employees and employers for terms of up to three years. The committee appoints a member as presiding officer. Local Apprenticeship Committees:

- monitor the apprenticeship system, and the progress of apprentices in their trade, at the local level.
- help settle certain kinds of issues between apprentices and their employers.
- recommend improvements in apprenticeship training and certification to their trade's provincial apprenticeship committee.
- make recommendations to the Board regarding the appointment of members to their trade's PAC.

Provincial Apprenticeship Committees (PAC)

The Board establishes a PAC for each trade and, based on PAC recommendations, appoints a presiding officer and equal numbers of employees and employers for terms of up to three years. Most PACs have nine members. Provincial Apprenticeship Committees:

- identify the training needs and content for their trade.
- recommend to the Board the standards for training and certification for their trade.
- monitor the activities of local apprenticeship committees in their trade.
- make recommendations to the Board about the designation of trades and occupations.
- determine whether training of various kinds is equivalent to training provided in an apprenticeship program in the trade.
- may participate in resolving any apprenticeship-related disputes between employers and employees.

Electrician PAC Members

Mr. W. Land	Hinton	Presiding Officer
Mr. M. Brunner	Calgary	Employer
Mr. C. Gratton	Edmonton	Employer
Mr. A. Reimer	Edmonton	Employer
Mr. D Unrah	Fort McMurray	Employer
Mr. H. Gerrits	Grande Prairie	Employer
Mr. L. Elhart	Medicine Hat	Employer
Mr. W. Kondro	Vermilion	Employer
Mr. L. Gatner	Calgary	Employee
Mr. R. Gabert	Edmonton	Employee
Mr. T. Rosychuk	Edmonton	Employee
Mr. B. Setter	Fort McMurray	Employee
Mr. R. Loewen	Medicine Hat	Employee
Mr. K. Blain	Red Deer	Employee
Mr. C. Kyle	Red Deer	Employee

The Alberta Apprenticeship and Industry Training Board (Board)

The mandate of the Alberta Apprenticeship and Industry Training Board relates to the standards and requirements for training and certification in programs under the *Apprenticeship and Industry Training Act*. The Board provides advice to the Minister of Learning on the training and certification of people in designated trades and occupations and on the needs of the Alberta labour market for skilled and trained persons. The Board also makes orders and regulations respecting standards and requirements for apprenticeship programs and the training of apprentices and for training and certification in designated trades and occupations, and the criteria or requirements for granting and recognizing trade and other certificates.

The 13-member Board consists of a chair, eight members representing trades and four members representing other industries. Employer and employee representatives equally represent the trades and other industry members.

Safety Education

Safe working procedures and conditions, accident prevention and the preservation of health are of primary importance in apprenticeship programs in Alberta. These responsibilities are shared and require the joint efforts of government, employers, employees and the public. Therefore, it is imperative that all parties become aware of circumstances that may lead to injury or harm. Safe learning experiences and environments can be created by controlling the variables and behaviours that may contribute to or cause an accident or injury.

It is generally recognized that a safe attitude contributes to an accident free environment. Everyone will benefit as a result of a healthy, safe attitude towards prevention of accidents.

A tradesperson is possibly exposed to more hazards than any other person in the work force and, therefore, should be familiar with and apply the Occupational Health and Safety Act and Regulations dealing with personal safety and the special safety rules applying to each task.

Legal and Administrative Aspects of Safety

Accident prevention and the provisions of safe working conditions are the responsibilities of an employer and employee.

Employer's Responsibilities

The employer is responsible for:

- providing and maintaining safety equipment and protective devices.
- ensuring proper safe work clothing is worn.
- enforcing safe working procedures.
- providing safeguards for machinery, equipment and tools.
- observing all accident prevention regulations.
- training employees in the safe use and operation of equipment.

Employee's Responsibilities

The employee is responsible for:

- working in accordance with the safety regulations pertaining to the job environment.
- working in such a way as not to endanger themselves or fellow employees.

Occupational Health and Safety's Responsibilities:

Occupational Health and Safety (Alberta Human Resources and Employment) will conduct periodic inspections of the workplace to ensure that safety regulations for industry are being observed.

Technical Training Establishment

Alberta Learning, Apprenticeship and Industry Training offer your apprenticeship training program. Staff and facilities for delivering the program are supplied by:

- Northern Alberta Institute of Technology —main campus
- Southern Alberta Institute of Technology — main campus
- Northern Alberta Institute of Technology — Fairview College campus
- Keyano College
- Lakeland College
- Lethbridge Community College
- Medicine Hat College
- Red Deer College

Procedures for Recommending Revisions to the Course Outline

Apprenticeship and Industry Training, Industry Programs and Standards has prepared this course outline in partnership with the Electrician Provincial Apprenticeship Committee.

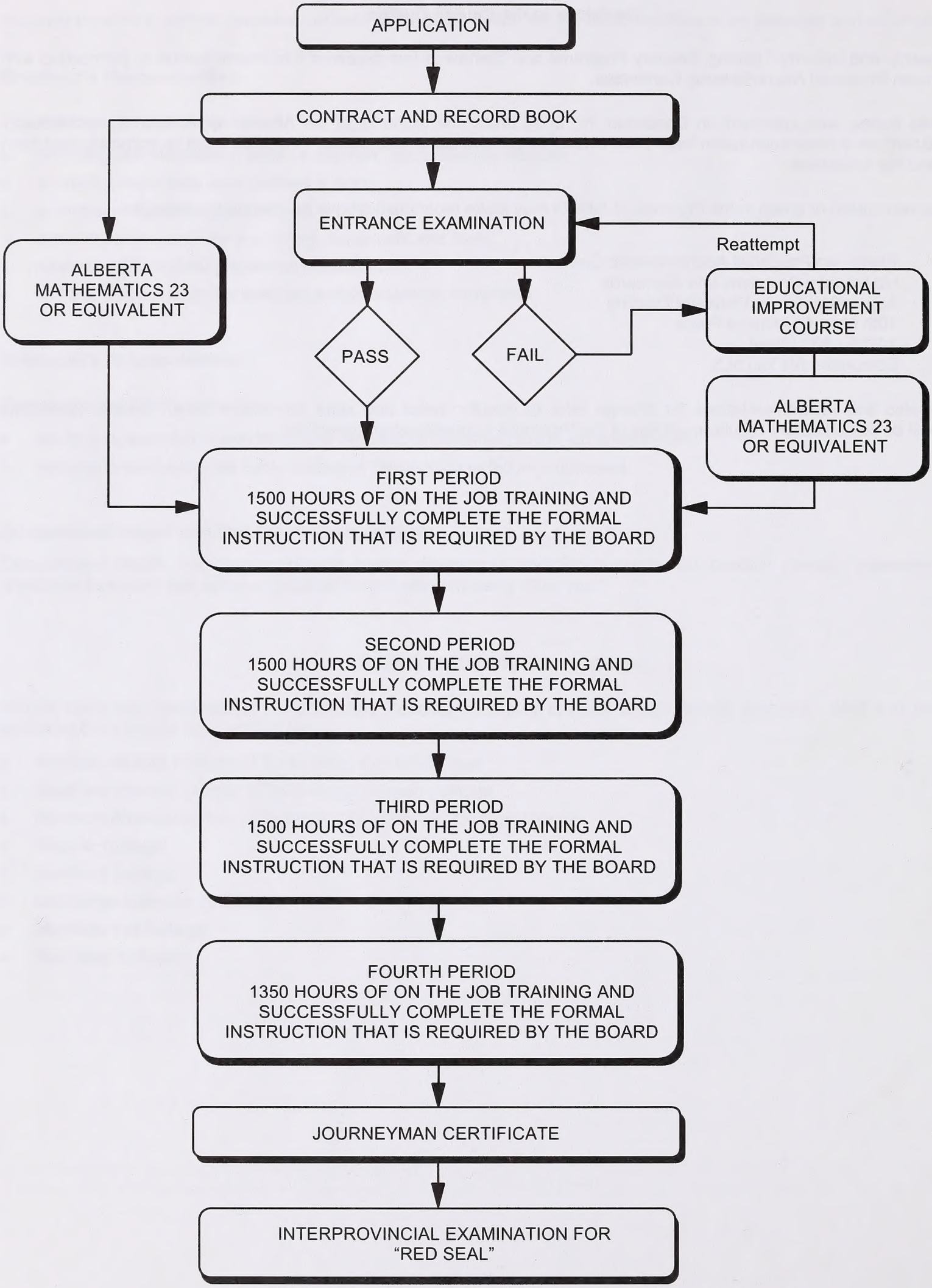
This course outline was approved on December 10, 2004 under the authority of the Alberta Apprenticeship and Industry Training Board on a recommendation from the Provincial Apprenticeship Committee. Valuable input is acknowledged from industry and the institutions.

Any concerned citizen or group in the Province of Alberta may make recommendations for change by writing to:

Electrician Provincial Apprenticeship Committee
c/o Industry Programs and Standards
Apprenticeship and Industry Training
10th floor, Commerce Place
10155 - 102 Street
Edmonton, AB T5J 4L5

It is requested that recommendations for change refer to specific areas and state references used. Recommendations received will be placed before regular meetings of the Provincial Apprenticeship Committee.

Apprenticeship Route Toward Certification



Electrician Training Profile

First Period
(8 Weeks 30 Hours Per Week – Total of 240 Hours)

SECTION ONE

CIRCUIT FUNDAMENTALS — **80 Hours**

A	B	C
Basic Mathematics — 10 Hours	Composition of Matter — 4 Hours	Current, Voltage, and Resistance — 10 Hours
D	**E**	**F**
Characteristics of Conductors — 6 Hours	Series Resistive Circuits — 8 Hours	Parallel Resistive Circuits — 10 Hours
G	**H**	**I**
Series-Parallel Resistive Circuits — 10 Hours	Work, Energy, Power and Efficiency — 10 Hours	Edison 3-Wire Distribution Systems — 12 Hours

SECTION TWO

EMF SOURCES — **32 Hours**

A	B	C
Cells and Batteries — 8 Hours	Magnetism — 8 Hours	Electromagnetism and Electromagnetic Induction — 8 Hours
D		
Generators — 8 Hours		

SECTION THREE

LAB FUNDAMENTALS — **30 Hours**

A	B	C
Safety — 6 Hours	Meters — 8 Hours	Conductors — 6 Hours
D	**E**	
Splicing and Terminating (Low Voltage) — 4 Hours	Resistors — 6 Hours	

SECTION FOUR

CONTROLS AND SWITCHING CIRCUITS — **48 Hours**

A	B	C
Switching Circuits — 10 Hours	Basic Circuits Using Buzzers and Chimes — 12 Hours	Relays and Controls — 12 Hours
D	**E**	
Low Voltage Switching — 10 Hours	Residential Alarm Systems and Smoke Alarms — 4 Hours	

SECTION FIVE

CANADIAN ELECTRICAL CODE PART I AND BLUEPRINTS — **50 Hours**

A	B	C
Introduction to Code — 4 Hours	General Rules — 4 Hours	Conductor Materials and Sizes — 4 Hours
D	**E**	**F**
Service and Grounding Requirements — 6 Hours	Service Feeders and Branch Circuits — 6 Hours	Wiring Methods — 8 Hours
G	**H**	**I**
Installation of Electrical Equipment — 4 Hours	Installation of Lighting Equipment — 4 Hours	Electrical Apprenticeship Training Program Orientation — 2 Hours

J	K	L
Orthographic Projection / Diagrams 2 Hours	Dimensioning and Scaling / Print and Diagram Nomenclature / Construction Drawings 2 Hours	Print Reading / Applied Drawings 4 Hours

Second Period
(8 Weeks 30 Hours Per Week – Total of 240 Hours)

SECTION ONE

ALTERNATING CURRENT (AC) CIRCUIT PROPERTIES
36 Hours

A	B	C
Review of Math Skills 4 Hours	Review of 1st Period Theory 2 Hours	Fundamentals of Alternating Current 6 Hours
D	**E**	**F**
Introduction to AC Circuits 6 Hours	Inductance and Inductive Reactance 6 Hours	Capacitance and Capacitive Reactance 6 Hours
G		
Power Relationships 6 Hours		

SECTION TWO

RLC CIRCUITS
76 Hours

A	B	C
Introduction to Series AC Circuits 10 Hours	Series Resistive-Reactive Circuits 12 Hours	Series RLC Circuits 14 Hours
D	**E**	**F**
Introduction to Parallel ac Circuits 10 Hours	Parallel RLC Circuits 14 Hours	Power Factor Correction 16 Hours

SECTION THREE

CANADIAN ELECTRICAL CODE PART I
42 Hours

A	B	C
Introduction to Second Period Canadian Electrical Code 2 Hours	Service Conductor Ampacity for a Single Dwelling 4 Hours	Services and Service Equipment for a Single Dwelling 2 Hours
D	**E**	**F**
Feeder and Branch Distribution Requirements for a Single Dwelling 2 Hours	Class 1 and Class 2 Circuits 2 Hours	Grounding Requirements for a Single Dwelling 2 Hours
G	**H**	**I**
Service Ampacity for Apartments and Similar Buildings 4 Hours	Service Protection and Controls for Apartments and Similar Buildings 2 Hours	Electric Discharge Lighting, Emergency Systems and Unit Equipment 2 Hours
J	**K**	**L**
Overview of Section 18 2 Hours	Class 1 Wiring Methods 4 Hours	Class 1 Locations – Section 20 2 Hours
M	**N**	**O**
Electrical Installations in Patient Care Areas 2 Hours	Installations in Class II Locations 2 Hours	Installations in Class III Locations 2 Hours
P	**Q**	
Corrosive and Wet Locations Section 22 4 Hours	Capacitor Bank Installations 2 Hours	

SECTION FOUR

PLANS AND DIAGRAMS

10 Hours

A

Diagrams

2 Hours

B

Specifications

4 Hours

C

Drawings and Plans

4 Hours

SECTION FIVE

HEATING AND COOLING CONTROLS

36 Hours

A

Principles of Automatic Heating and Cooling Controls

8 Hours

B

Temperature Sensing and Control Devices

6 Hours

C

Basic Gas-Fired Forced-Air Heating Systems

8 Hours

D

Mid-Efficiency Gas-Fired Forced-Air Heating Systems

4 Hours

E

Basic Hot Water Heating Systems

2 Hours

F

Cooling Systems

4 Hours

G

HVAC Rooftop Units

4 Hours

SECTION SIX

MAGNETIC CONTROL AND SWITCHING CIRCUITS

40 Hours

A

Drawings

2 Hours

B

Construction of Control Relays and Contactors
Operations of Relays

6 Hours

C

Protection Devices (General)
Protection Devices (Motor Circuits)

4 Hours

D

Construction of Magnetic Motor Starters
Overload Devices

6 Hours

E

Single Motor Control Part A
Single Motor Control Part B
Pilot Devices and Symbols

6 Hours

F

Diagram Conversion

6 Hours

G

Reversing Magnetic Starters

4 Hours

H

Transformers

6 Hours

THIRD PERIOD
(8 Weeks 30 Hours Per Week – Total of 240 Hours)

SECTION ONE

THREE-PHASE PRINCIPLES
78 Hours

A	B	C
Electrical Theory Review 12 Hours	Series RLC Circuits 2 Hours	Parallel RLC Circuits 2 Hours
D	**E**	**F**
Three-Phase Systems (General) 4 Hours	Three-Phase Systems Wye Connections 30 Hours	Three-Phase Systems Delta Connection 28 Hours

SECTION TWO

THREE-PHASE POWER MEASUREMENT AND POWER FACTOR CORRECTION
22 Hours

A	B	C
Three-Phase Power 6 Hours	Three-Wattmeter Connection 4 Hours	Power Factor Correction 12 Hours

SECTION THREE

THREE-PHASE MOTOR PRINCIPLES
28 Hours

A	B	C
Three-Phase Induction Motors 12 Hours	Induction Motor Characteristics 14 Hours	Phase Converters 2 Hours

SECTION FOUR

TRANSFORMERS
66 Hours

A	B	C
Transformers 6 Hours	Induction, Turns Ratio Polarity and Multiple Winding 8 Hours	Transformer Load Test 6 Hours
D	**E**	**F**
Transformer Losses, Impedance Voltage and Paralleling 8 Hours	Autotransformers 8 Hours	Transformer Connections 24 Hours
G		
Energy Measurement 6 Hours		

SECTION FIVE

CANADIAN ELECTRICAL CODE / NETWORK WORKPLACE COACHING SKILLS AND ADVISORY
46 Hours

A	B	C
Grounding and Bonding 6 Hours	Protection and Control 10 Hours	Installation of Equipment 6 Hours
D	**E**	**F**
Individual Motors 8 Hours	Motor Banks 6 Hours	Sections 68,72 and 76 6 Hours
A		
Workplace Coaching Skills and Advisory Network 4 Hours		

FOURTH PERIOD
(12 Weeks 30 Hours Per Week – Total of 360 Hours)

SECTION ONE

ELECTRICAL THEORY REVIEW
10 Hours

A	B	C
Basic Electrical Circuits 2 Hours	Series RLC Circuits 2 Hours	Parallel RLC Circuits 2 Hours

D
Three-Phase Basics 4 Hours

SECTION TWO

DIRECT CURRENT (DC) MACHINES
44 Hours

A	B	C
Direct Current Machines 6 Hours	Direct Current Generator Principles 10 Hours	Types of Direct Current Generators 8 Hours

D	E
Types of Direct Current Motors (Part I) 10 Hours	Types of Direct Current Motors (Part II) 10 Hours

SECTION THREE

ALTERNATING CURRENT (AC) MACHINES
38 Hours

A	B	C
Three-Phase Alternators 8 Hours	Paralleling Alternators 6 Hours	Synchronous Motors (Part 1) 6 Hours

D	E	F
Synchronous Motors (Part II) 6 Hours	Single Phase Motors (Part I) 6 Hours	Single Phase Motors (Part II) 6 Hours

SECTION FOUR

CONTROL AND SWITCHING / PLC
50 Hours

A	B	C
Drawings and Basic Circuits 6 Hours	Controls and Switching Circuits 6 Hours	Special Control Circuits 6 Hours

D	E
Diagram Conversion 6 Hours	Introduction to Programmable Logic Controllers 26 Hours

SECTION FIVE

FIRE ALARM SYSTEMS
30 Hours

A	B	C
Fire Detection and Alarm Systems 6 Hours	Fire Detection and Alarm System Regulations 6 Hours	Fire Alarm System Occupancy Classifications 6 Hours

D
Wiring Procedures for Fire Alarm Systems 12 Hours

SECTION SIX

ELECTRONICS / DIODES / RECTIFIERS
38 Hours

A	B	C
Electrical Properties and Measuring Instruments 18 Hours	Diodes and Rectifier Circuits 10 Hours	Application of Diodes and Rectifiers 10 Hours

SECTION SEVEN

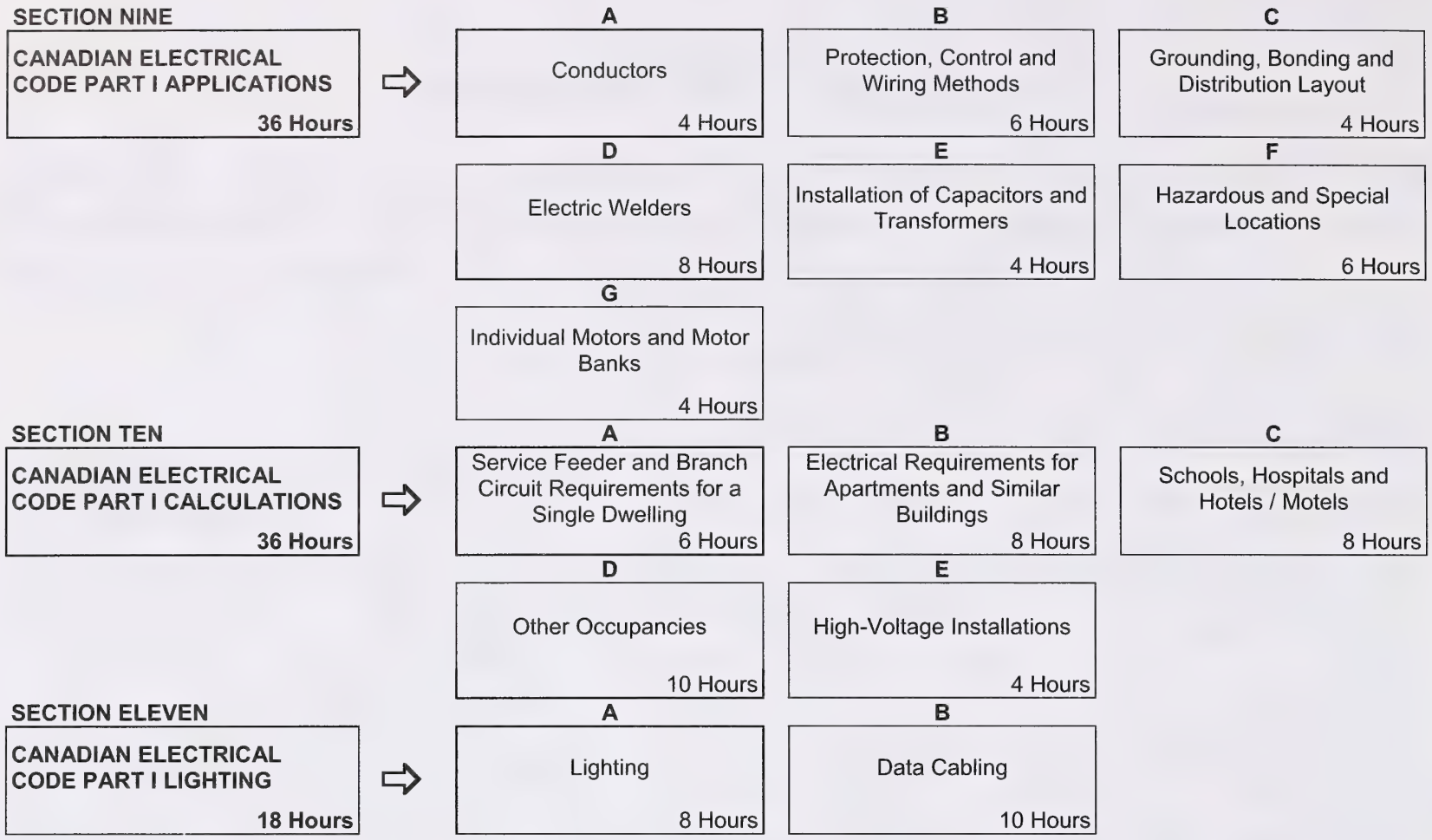
ELECTONICS / POWER / SWITCHING
30 Hours

A	B	C
Transistors and Photo Devices 10 Hours	Thyristors 10 Hours	Practical Applications of Thyristors Circuits 10 Hours

SECTION EIGHT

ELECTRONICS / APPLICATIONS
30 Hours

A	B	C
Voltage Regulators 8 Hours	Uninterrupted Power Supply (UPS) systems 10 Hours	Variable Frequency Drives 12 Hours



NOTE: The hours stated are for guidance and should be adhered to as closely as possible. However, adjustments must be made for rate of apprentice learning, statutory holidays, registration and examinations for the training establishment and Apprenticeship and Industry Training

FIRST PERIOD TECHNICAL TRAINING
ELECTRICIAN TRADE
COURSE OUTLINE

UPON SUCCESSFUL COMPLETION OF THIS PROGRAM THE APPRENTICE SHOULD BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

SECTION ONE: ..... CIRCUIT FUNDAMENTALS ..... 80 HOURS

A. Basic Mathematics ..... 10 Hours

Outcome: ***Solve trade-related problems using basic mathematical skills.***

1. Recognize basic arithmetic symbols.
2. Add whole, decimal and fractional numbers.
3. Subtract whole, decimal and fractional numbers.
4. Multiply whole, decimal and fractional numbers.
5. Divide whole, decimal and fractional numbers.
6. State the correct sequence for arithmetical operations and solve equations which use brackets.

B. Composition of Matter ..... 4 Hours

Outcome: ***Describe the relationship between atomic structure and electron flow.***

1. Describe the basic composition of matter.
2. Describe the basic structure of the atom.

C. Current, Voltage, and Resistance ..... 10 Hours

Outcome: ***Define voltage, current and resistance and predict how changing the value of any one of them affects the circuit.***

1. Demonstrate the math skill required for transposition of equations.
2. Describe an electric current.
3. Describe voltage.
4. Describe resistance and state and apply Ohm's law.
5. Verify relationship between voltage, current and resistance according to Ohm's law.

D. Characteristics of Conductors ..... 6 Hours

Outcome: ***Describe conductors, semiconductors and insulators and calculate the resistance of conductors. Describe the composition of fibre optic cables and their proper handling and installation.***

1. Demonstrate the math skills required to calculate the resistance of a conductor of specific dimensions.
2. Describe the factors affecting resistance.
3. Calculate the resistance of a conductor of specific dimensions.
4. Describe the electrical properties of materials.

5. Describe fibre optic systems.

E. Series Resistive Circuits ..... 8 Hours

Outcome: ***Identify a series resistive circuit and analyze the relationships between current, resistance and voltage.***

1. Define a series circuit and calculate current in a series circuit.
2. State the formula for total resistance and calculate resistance in a series circuit.
3. State and apply Kirchhoff's voltage law to a series circuit.
4. Define the terms ratio and direct proportion and perform calculations using both.
5. State the relationship between the resistive values of components and their voltage drops and solve problems using the voltage divider rule.
6. Determine the voltage drop across a closed-or-open-circuit component in a series circuit.
7. Verify Kirchhoff's current and voltage laws in a series resistive circuit.

F. Parallel Resistive Circuits ..... 10 Hours

Outcome: Analyze the voltage, current and resistance characteristics of a parallel circuit.

1. Define a parallel circuit.
2. Calculate the total resistance of a parallel circuit using the appropriate formulas.
3. State and apply Kirchhoff's current law to a parallel circuit.
4. Describe the effects of open circuits on a parallel circuit.
5. Use the current divider principle to calculate branch currents.
6. Verify Kirchhoff's current laws in a parallel resistive circuit.

G. Series-Parallel Resistive Circuits ..... 10 Hours

Outcome: ***Identify and analyze a series-parallel resistive circuit.***

1. Identify resistors that are in series.
2. Identify resistors that are in parallel.
3. Calculate the total resistance of a series-parallel circuit.
4. Apply Kirchhoff's current law.
5. Apply Kirchhoff's voltage law.
6. Solve problems involving series-parallel circuits.
7. Verify the relationship of current, voltage and resistance in each part of a series/parallel circuit.

H. Work, Energy, Power and Efficiency ..... 10 Hours

Outcome: ***Describe the terms mass, work, force, work, energy and power; describe how they are interrelated mechanically and electrically; and calculate the efficiency of simple circuits.***

1. Describe mass, weight and force.
2. Describe work, energy and power.

3. Describe electrical relationships of work, energy and power.
4. Calculate efficiency, voltage drop and line loss.
5. Verify the power formulae.

I. Edison 3-Wire Distribution Systems ..... 12 Hours

Outcome: Identify and analyze an Edison 3-wire system.

1. Identify an Edison 3-wire system.
2. Analyze an Edison 3-wire system.
3. Describe and calculate the effects of a high resistance or broken neutral in an Edison 3-wire system.
4. Verify the effects of a high resistance or broken neutral in an Edison 3-wire system.

SECTION TWO: ..... EMF SOURCES ..... 32 HOURS

A. Cells and Batteries ..... 8 Hours

Outcome: Describe some common batteries, their care and handling, and recharging precautions.

1. Define the basic terminology of cells.
2. Describe the construction and operation of a basic primary cell.
3. Describe the construction and operation of three types of lead-acid batteries.
4. Describe the construction and operation of a nickel-cadmium battery.
5. Describe the hazards and precautions to be observed when charging batteries.
6. Describe the three common battery performance ratings.
7. Calculate the affects of battery internal resistance.

B. Magnetism ..... 8 Hours

Outcome: Describe a magnetic material and define the terms used to express the characteristics of magnetic materials.

1. Describe the properties of magnetic materials.
2. Define the terminology related to magnetism.

C. Electromagnetism and Electromagnetic Induction ..... 8 Hours

Outcome: Describe electromagnetism and electromagnetic induction.

1. Describe electromagnetism and basic design considerations for electromagnetic devices.
2. Describe how an induced voltage is generated.
3. Describe the process of electromagnetic induction.

D. Generators ..... 8 Hours

Outcome: ***Describe the voltage and current characteristics of an AC and a DC generator.***

1. Describe the basic construction of a generator.
2. State how a generator produces a voltage and identify the factors affecting its value.
3. State how a generated voltage can be connected to supply alternating current or direct current to a load.

SECTION THREE: ..... LAB FUNDAMENTALS ..... 30 HOURS

A. Safety ..... 6 Hours

Outcome: ***Demonstrate knowledge of safe work practices, safety procedures and responsibility for safety in the workplace.***

1. Describe the workplace safety programs in Alberta and safety procedures relating to the electrician trade.
2. Identify and describe the safe use of common hand tools and equipment related to the electrician trade.
3. Identify and describe the safe use of common power and specialty tools related to the electrician trade.
4. Identify and describe lockout procedures.

B. Meters ..... 8 Hours

Outcome: ***Describe proper use, care and safety precautions for various electrical meters.***

1. State the applications of the various meters.
2. List the precautions that must be observed when using meters.
3. Interpret the readings of analog meters.
4. Interpret the readings of digital meters.
5. Recognize the connections for various meters.

C. Conductors ..... 6 Hours

Outcome: ***Describe basic forms and types of conductors, understand the methods used to identify conductor size, and predict the effects of conductor size on voltage drop in a circuit.***

1. State the common types of conductor materials.
2. List the common forms of conductors.
3. Calculate the cross-sectional area of conductors.
4. Determine the AWG wire size with a wire gauge.
5. Calculate the approximate voltage drop due to conductor resistance.

D. Splicing and Terminating (Low Voltage) ..... 4 Hours

Outcome: ***Describe how to make effective splices, taps and terminations.***

1. List and describe four classes of terminations or connections used in the electrical trade.
2. Describe the proper method for stripping conductors and insulating splices.
3. Describe three common wire connections.

4. Describe the techniques used for mechanical and compression splices and terminations.
5. Describe the problems specific to aluminium conductor splices and terminations.

E. Resistors ..... 6 Hours

Outcome: ***Identify various resistors and interpret their ratings.***

1. List two categories of resistors and describe their construction.
2. Explain the methods used to determine the ratings of fixed resistors.
3. Use a colour code chart to determine the resistance of a resistor.

SECTION FOUR: ..... CONTROLS AND SWITCHING CIRCUITS ..... 48 HOURS

A. Switching Circuits ..... 10 Hours

Outcome: ***Describe specific circuit switching arrangements by creating schematic drawing and wiring diagrams and demonstrating their connections in a lab.***

1. Draw symbols that are commonly used in schematic and wiring diagrams.
2. Verify the switching arrangement of various types of switches.
3. List applications of various types of switches.
4. Draw schematic and wiring diagrams for typical lighting circuits and demonstrate their connection.

B. Basic Circuits Using Buzzers and Chimes ..... 12 Hours

Outcome: ***Design, draw and connect a variety of series and parallel circuits.***

1. Determine when to connect pushbuttons and buzzers in series and parallel for various operations and demonstrate their connection.
2. Explain the difference between a common return call system and a selective return call system and demonstrate their connection.
3. Describe how to connect a set of door chimes and how to add an additional set if required and demonstrate the connection of circuits using buzzers and chimes.

C. Relays and Controls ..... 12 Hours

Outcome: ***Analyze and connect control circuits that use relays.***

1. Define specific terms that are used when referring to control circuits.
2. Identify the parts of a relay.
3. Describe the operating principle of a relay.
4. Draw the symbols that are commonly used in control circuits.
5. Draw schematic and wiring diagrams using a relay.
6. Demonstrate the connection of circuits using relays.

D. Low Voltage Switching ..... 10 Hours

Outcome: ***Analyze and connect low voltage switching circuits.***

1. Describe the basic concepts of a low voltage switching system.
2. State the advantages of low voltage switching.
3. Describe the operation of a low voltage switching system.
4. Demonstrate the connection of low voltage circuits.

E. Residential Alarm Systems and Smoke Alarms ..... 4 Hours

Outcome: ***Describe the operation of, and troubleshoot, residential alarm systems and smoke alarms.***

1. 1. Identify various types of sensing and alarm devices used in residential alarm systems.
2. 2. Describe the operation of a basic residential alarm system.
3. 3. Identify the function and applications of residential smoke alarms.

SECTION FIVE: ..... CANADIAN ELECTRICAL CODE PART I AND BLUEPRINTS ..... 50 HOURS

A. Introduction to Code ..... 4 Hours

Outcome: ***Understand why and how the Canadian Electrical Code Part I, and the Alberta Electrical STANDATA are used to provide minimum standards for electrical installations in the province Find information within the Canadian Electrical Code Part I, and know who is responsible for electrical installations.***

1. Explain the purpose of the Canadian Electrical Code Part I.
2. Describe the procedures for the acceptance of the Canadian Electrical Code by the provinces and the local authorities.
3. Describe the function of the electrical STANDATA.
4. Describe the organizational layout of the CEC.
5. Locate specific information in the CEC using a variety of methods.
6. Identify those responsible for an electrical installation.

B. General Rules ..... 4 Hours

Outcome: ***Administrative, safety, maintenance and enclosure requirements for an electrical installation with an understanding of the terms used within Section 2 of the CEC.***

1. Define the specific terms from Section 2 that apply to the first period code program.
2. Become familiar with the administrative rules in Section 2.
3. List the technical requirements described in Section 2.

C. Conductor Material and Sizes ..... 4 Hours

Outcome: ***Determine size, insulation type and insulation colour required for a conductor, based upon its condition of use.***

1. Define specific terms from Section 4, that apply to the first period code program.

2. Apply specific rules of Section 4 to determine conductor sizes, with reference to the appropriate tables and appendices.
3. Determine the allowable ampacity of a conductor given load current and conditions of use.
4. Describe the conditions for use of flexible cords and equipment wire and be able to determine their allowable ampacity.
5. Recognize neutral conductors and determine their size.
6. 6. Recall the CEC standards for conductor colours.

D. Service and Grounding Requirements ..... 6 Hours

Outcome: ***Describe the components, installation methods and proper grounding of overhead and underground consumer's services to a single dwelling.***

1. Define specific terms from Section 6 that apply to a residential occupancy.
2. Describe the wiring methods used for the installation of overhead services.
3. Describe the wiring methods used for the installation of underground services.
4. List the requirements for service equipment in a single dwelling.
5. Define specific terms from Section 10 that apply to a single dwelling.
6. Indicate the various points for grounding and bonding of a consumer service and determine the size of these conductors.

E. Service Feeders and Branch Circuits ..... 6 Hours

Outcome: ***Determine the loading on services, feeders and branch circuits for single dwellings.***

1. Define specific terms from Section 8 that apply to a residential occupancy.
2. Determine the minimum ampacity of service or feeder conductors supplying a single dwelling.
3. Determine the minimum required number of branch circuit positions for a single dwelling.
4. Determine the ampacity requirements for branch circuit conductors and ampere ratings of overcurrent devices applicable to a single dwelling.

F. Wiring Methods ..... 8 Hours

Outcome: ***Define and describe appropriate wiring methods for common installations.***

1. Define specific terms from Section 12 that apply to a residential occupancy.
2. Demonstrate an understanding of the General Requirements sub-section in Section 12.
3. Demonstrate an understanding of the Conductors, General, sub-section in Section 12.
4. Describe the conditions for use of exposed wiring located outdoors.
5. Describe the conditions for use of non-metallic sheathed cable.
6. Describe the conditions for use of armoured and mineral-insulated cable.
7. Describe the conditions for use of raceways in general.
8. Describe the conditions for use of specific raceways.
9. Describe the installation of boxes, cabinets and outlets.

G. Installation of Electrical Equipment ..... 4 Hours

Outcome: ***Describe the procedures for selecting receptacles and designing branch circuits for a residential occupancy and for domestic water heating and cooking appliances. State the requirements pertaining to storage batteries.***

1. Define specific terms from Section 26 that apply to the first period code program.
2. Apply specific rules of Section 26 that deal with the electrical installations in battery rooms.
3. List the information required when selecting a receptacle for a specific application.
4. Determine the branch circuit requirements, number and location of receptacles required for areas (other than kitchens) of a residential occupancy in general and specifically, a single dwelling.
5. Describe the types of areas that require GFCIs and AFCIs and explain the operation of a GFCI and an AFCI.
6. Determine the branch circuits required, the number and type of receptacles required and the location of each for a kitchen.
7. Determine where the disconnecting means for a furnace must be installed.

H. Installation of Lighting Equipment ..... 4 Hours

Outcome: ***Describe the wiring techniques involved with lighting installations and the terminology associated with lighting systems.***

1. Define specific terms from Section 30 that apply to the first period code program.
2. Become familiar with the general requirements for interior lighting equipment.
3. Describe the factors identified in Section 30, which relate to the location of lighting equipment.
4. Describe the factors identified in Section 30, which relate to the installation of lighting equipment.
5. Describe the methods of wiring various types of lighting equipment.
6. Describe the bonding requirements of lighting equipment.
7. Recall the ratings and control methods of lampholders.

I. Electrician Apprenticeship Training Program Orientation ..... 2 Hours

Outcome: ***Understand the role of the tradesmen, employers, Local Apprenticeship Committees, the Provincial Apprenticeship Committee and Alberta Apprenticeship and Industry Training in the development and maintenance of the electrician trade in Alberta.***

1. Describe the apprenticeship training system in Alberta.
2. Study the training profile of the electrician apprenticeship in Alberta.
3. Describe the electrician program outline learning outcomes and objectives.
4. Describe the responsibilities for the Contract of Apprenticeship by the apprentice, employer and Alberta Apprenticeship and Industry Training.
5. Describe a variety of employment opportunities for electricians.
6. Become familiar with the contents of the apprenticeship training record book.

J. Ortho Graphic Projection / Diagrams ..... 2 Hours

Outcome: ***Identify the various views of a three-dimensional object and obtain information from each one of these views.***
Understand and identify block diagrams, wiring diagrams and schematic drawings.

1. Differentiate between the basic views of objects using orthographic projection.
2. Relate basic orthographic projections to views of a building.
3. Identify the lines commonly found on a blueprint.
4. Distinguish between a block diagram and a wiring diagram.
5. Read and interpret electrical schematic drawings.

K. Dimensioning and Scaling / Print and Diagram Nomenclature / Construction Drawings..... 2 Hours

Outcome: ***Read and interpret information from a drawing or print.***
Identify and interpret commonly used electrical symbols, abbreviations and terms.
List the different types of drawings and their uses in a set of construction drawings.

1. Read and interpret dimensions from a drawing or print.
2. Use a scale to determine dimensions from a drawing.
3. Identify commonly used electrical symbols.
4. Interpret common abbreviations used on prints and drawings.
5. Interpret technical terms used on prints and drawings.
6. List the different types of drawings and their uses in a set of construction drawings.
7. Describe the disciplines and types of drawings used in a set of construction drawings.

L. Print Reading / Applied Drawings..... 4 Hours

Outcome: ***Interpret plan of a simple residential electrical installation.***
Interpret applied drawings of a simple residential electrical installation.

1. Extract information from a print.
2. Interpret a drawing of an overhead service for a single-family dwelling.
3. Interpret a drawing of an underground service for a single-family dwelling.
4. Interpret a partial floor plan of a typical residential electrical installation and do a material estimate.
5. Calculate the main service requirements for a single-family dwelling.

SECOND PERIOD TECHNICAL TRAINING
ELECTRICIAN TRADE
COURSE OUTLINE

UPON SUCCESSFUL COMPLETION OF THIS PROGRAM THE APPRENTICE SHOULD BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

SECTION ONE: .....ALTERNATING CURRENT (AC) CIRCUIT PROPERTIES ..... 36 HOURS

A. Review of Math Skills ..... 4 Hours

Outcome: ***Perform basic trade related calculations.***

1. Perform arithmetic operations in the correct sequence.
2. Transpose an equation to make any stated term the subject.
3. Determine the squares or square roots of mathematical expressions.
4. Convert numbers to and from scientific notation.
5. Perform calculations involving SI prefixes.

B. Review of 1st Period Theory ..... 2 Hours

Outcome: ***Describe the basic electrical concepts and demonstrate their relationships with calculations.***

1. Describe the relationship between resistance, current and voltage.
2. Perform power calculations for a circuit, given any three of the following: resistance, current, voltage or power.
3. Solve problems involving series resistive circuits.
4. Solve problems involving parallel resistive circuits.
5. Solve problems for circuits containing combinations of series and parallel components.
6. Use Kirchhoff's law to solve basic Edison 3-wire distribution circuits.

C. Fundamentals of Alternating Current ..... 6 Hours

Outcome: ***Describe the fundamental characteristics of AC circuits.***

1. Explain the generation of an AC sine wave.
2. Determine the output frequency of an AC generator.
3. Calculate standard AC sine wave values.
4. Demonstrate the relationship between sine waves and phasor diagrams.
5. List the factors affecting impedance in an AC circuit.

D. Introduction to AC Circuits ..... 6 Hours

Outcome: ***Understand and explain the current-limiting effects of resistance, inductance and capacitance in an AC circuit, and apply the mathematics necessary to deal with the information in this topic.***

1. Compare the three circuit properties: resistance, inductance and capacitance, with respect to their current limiting effects.

2. Explain the effects of AC on the resistance of a circuit.
3. Use the Pythagorean theorem to solve right triangles.
4. Use trigonometric functions to solve right triangles.
5. Solve problems involving the addition of phasors.

E. Inductance and Inductive Reactance ..... 6 Hours

Outcome: ***Apply the concepts of inductance and induction to DC and AC circuits.***

1. Describe a basic inductor (coil).
2. Define and describe inductance and the factors which affect it.
3. Describe induction and its effects.
4. Describe the effects of an inductor in a DC circuit.
5. Describe the effects of an inductor in an AC circuit.
6. Analyze an AC inductive circuit.
7. Describe the power relationships in an inductive circuit.
8. Confirm the existence of inductive reactance in inductive circuits.

F. Capacitance and Capacitive Reactance ..... 6 Hours

Outcome: ***Apply the concepts of capacitors and describe their use in DC and AC circuits.***

1. Define capacitance and describe the construction of a basic capacitor.
2. Describe dielectric strength and state the unit of measurement for electric charge.
3. Calculate the value for the time constant in a DC resistor-capacitor circuit.
4. Analyze an AC capacitive circuit.
5. Describe the power relationships in a capacitive circuit.
6. Describe capacitor types and applications.
7. Confirm the existence of inductive reactance in inductive circuits and effects of discharge rate when resistance is increased.

G. Power Relationships ..... 6 Hours

Outcome: ***Calculate power, reactive power and apparent power in AC circuits containing R, X_L, and X_C.***

1. Differentiate between reactive power due to inductance and reactive power due to capacitance.
2. Determine the power, apparent power, reactive power and power factor angle in an AC circuit.

SECTION TWO: ..... RLC CIRCUITS ..... 76 HOURS

A. Introduction to Series AC Circuits ..... 10 Hours

Outcome: ***Describe how resistors, inductors and capacitors affect an AC circuit when they are connected in series.***

1. Analyze an AC circuit containing resistors connected in series.

2. Analyze an AC circuit containing inductors connected in series.
3. Analyze an AC circuit containing capacitors connected in series.
4. Confirm the formulas for capacitive and capacitive reactance when capacitors are connected in series.

B. Series Resistive-Reactive Circuits ..... 12 Hours

Outcome: ***Analyze series circuits that contain resistance and reactance.***

1. Analyze a circuit containing resistance and inductive reactance connected in series.
2. Describe the characteristics of a coil.
3. Solve problems involving a resistor and an inductor connected in series.
4. Analyze a circuit containing a resistor and a capacitor connected in series.
5. Solve problems involving a resistor and a capacitor connected in series.

C. Series RLC Circuits ..... 14 Hours

Outcome: ***Analyze series RLC circuits to solve for unknown circuit values and describe applications of this type of circuit.***

1. Analyze a circuit containing resistance, inductive reactance and capacitive reactance connected in series.
2. Explain the practical characteristics of series RLC circuits.
3. Solve problems involving a resistor, a coil and a capacitor connected in series.

D. Introduction to Parallel AC Circuits ..... 10 Hours

Outcome: ***Analyze and connect AC circuits that contain resistors, inductors or capacitors connected in parallel.***

1. Analyze an AC circuit containing resistors connected in parallel.
2. Analyze an AC circuit containing inductors connected in parallel.
3. Analyze an AC circuit containing capacitors connected in parallel.

E. Parallel RLC Circuits ..... 14 Hours

Outcome: ***Analyze and connect AC parallel circuits that contain resistance, inductance and capacitance.***

1. Analyze a circuit containing resistance, inductive reactance and capacitive reactance connected in parallel.
2. Solve problems involving a heater connected in parallel with a motor.
3. Solve problems involving motors connected in parallel.

F. Power Factor Correction ..... 16 Hours

Outcome: ***Analyze power factor correction on a system that has capacitance connected in parallel to an inductive load.***

1. Analyze a circuit that has a capacitive load in parallel with a motor.
2. State the reasons for and list the methods of maintaining a high power factor in an electrical plant.
3. Calculate the kvar rating of a capacitor bank to correct the circuit power factor using the power method.

4. Calculate the kvar rating of a capacitor bank to correct the circuit power factor using the current method.

SECTION THREE: ..... CANADIAN ELECTRICAL CODE - PART I ..... 42 HOURS

A. Introduction to Second Period Canadian Electrical Code ..... 2 Hours

Outcome: ***Recall terms and concepts learned in your first period Code studies.***

1. Demonstrate the ability to apply certain rules from 1st period code.

B. Service Conductor Ampacity for a Single Dwelling ..... 4 Hours

Outcome: ***Calculate the minimum ampacity of conductors to single dwellings.***

1. Define the specific terms from Section 8 that apply to the second period code program and list the Section 8 topics.
2. Determine the calculated current for the service conductors supplying a single dwelling.
3. Determine the minimum ampacity for the service conductors supplying a single dwelling.
4. Determine the minimum AWG size of conductors and the trade size of conduit required for the service conductors supplying a single dwelling.

C. Services and Service Equipment for a Single Dwelling ..... 2 Hours

Outcome: ***State the requirements of a service for a single dwelling.***

1. Define the terms from Section 6 that apply to the second period code program and list the Section 6 subtopics.
2. Determine the requirements for metering equipment for a single dwelling.
3. Determine the requirements for service protection and control equipment for a single dwelling.
4. Determine the requirements for overhead service equipment and conductors.
5. Determine the requirements for underground service equipment and conductors.

D. Feeder and Branch Distribution Requirements for a Single Dwelling ..... 2 Hours

Outcome: ***Determine the branch circuit and feeder requirements for a single dwelling.***

1. Determine the requirements for a single dwelling panelboard.
2. Determine the requirements for typical single dwelling branch circuit conductors and overcurrent devices.

E. Class 1 and Class 2 Circuits ..... 2 Hours

Outcome: ***Identify Class 1 and Class 2 circuits and describe their CEC requirements.***

1. Define the terms from Section 16 that apply to the second period code program and list the Section 16 topics.
2. Determine the requirements for Class 1 and Class 2 circuits.
3. Identify the Class 2 circuits in a typical single dwelling.

F. Grounding Requirements for a Single Dwelling ..... 2 Hours

Outcome: ***Determine the grounding and bonding requirements for a single dwelling.***

1. Define the terms from Section 10 applicable to second period code.
2. Determine the requirements for grounding and bonding in a single dwelling.

G. Service Ampacity for Apartments and Similar Buildings ..... 4 Hours

Outcome: ***Determine the service, feeder and branch circuit requirements of an apartment building.***

1. Calculate the minimum ampacity required for a feeder conductor to a dwelling unit in an apartment complex.
2. Determine the demand load on an apartment house or public panelboard feeder conductor.
3. Determine the demand load on a parking lot panelboard feeder conductor.
4. Calculate the minimum ampacity required for the main service conductors in an apartment complex.
5. Determine the required size of a raceway when conductors of different sizes are installed.

H. Service Protection and Control for Apartments and Similar Buildings ..... 2 Hours

Outcome: ***Determine the requirements for equipment protection, control, grounding and bonding for apartments and similar buildings.***

1. Determine the requirements for service protection and control equipment for apartments and similar buildings.
2. Determine the requirements for grounding and bonding of apartments and similar buildings.

I. Electric Discharge Lighting, Emergency Systems and Unit Equipment ..... 2 Hours

Outcome: ***Determine the requirements for the installation of electric discharge lighting, emergency systems and unit equipment.***

1. Determine the requirements for the installation of electric discharge lighting.
2. Determine the requirements for the installation of emergency systems and unit equipment.

J. Overview of Section 18 ..... 2 Hours

Outcome: ***Describe the classification of hazardous locations and the general rules that apply to these locations.***

1. Define the specific terms from Section 18 that apply to the second period code program and list the Section 18 topics.
2. Interpret the general rules regarding installation in hazardous locations.

K. Class I Wiring Methods ..... 4 Hours

Outcome: ***Describe the installation requirements for Class I locations.***

1. Determine the requirements of an electrical installation in a Class I Zone 0 location.
2. Determine the requirements of an electrical installation in a Class I Zone 1 location.
3. Determine the requirements of an electrical installation in a Class I Zone 2 location.

L. Class I Locations - Section 20 ..... 2 Hours

Outcome: ***Recognize installations in which you could encounter Class I hazardous locations and understand specific wiring requirements that apply to each area.***

1. Define the specific terms from Section 20 that apply to the second period code program and list the Section 20 topics.
2. Determine the requirements for wiring and equipment in dispensing or refuelling stations for gasoline, propane and natural gas.
3. Determine the requirements for wiring and equipment in commercial garages.
4. Determine the requirements for wiring and equipment in residential storage garages.
5. Determine the requirements for wiring and equipment in bulk storage plants.
6. Determine the requirements for wiring and equipment in finishing process areas.
7. Determine the requirements for wiring and equipment in aircraft hangers.

M. Electrical Installations in Patient Care Areas ..... 2 Hours

Outcome: ***Determine the requirements for wiring and equipment in the specially defined areas of patient care facilities.***

1. Define the specific terms from Section 24 that apply to the second period code program and list the Section 24 topics.
2. Determine the requirements for wiring and equipment in patient care areas.
3. Determine the requirements for isolated systems in patient care areas.
4. Determine the requirements for essential electrical systems in patient care areas.

N. Installation in a Class II Location ..... 2 Hours

Outcome: ***Describe the various electrical requirements for a Class II location.***

1. Determine the requirements for an electrical installation in a Class II, Division 1 location.
2. Determine the requirements for an electrical installation in a Class II, Division 2 location.

O. Installation in a Class III Location ..... 2 Hours

Outcome: ***Determine the requirements for an electrical installation in a Class III location.***

1. Determine the requirements for an electrical installation in a Class III location.

P. Corrosive and Wet Locations - Section 22 ..... 4 Hours

Outcome: Describe acceptable electrical installation requirements in Category 1 and 2 locations.

1. Define the specific terms from Section 22 that apply to the second period code program and list the Section 22 subtopics.
2. Determine the requirements for electrical equipment in a Category 1 and Category 2 location.
3. Determine the requirements for electrical wiring in a Category 1 and Category 2 location.

Q. Capacitor Bank Installation ..... 2 Hours

Outcome: ***Determine the conductor sizes and overcurrent ratings for capacitor branch circuits and feeders and the location and ratings of any disconnecting means that are used.***

1. Determine the conductor sizes for various capacitor loads.
2. Determine the rating of the overcurrent protection required for capacitor loads.
3. Determine the requirements for capacitor discharge circuits.
4. Determine the location and current rating of capacitor disconnecting means.

SECTION FOUR: ..... PLANS AND DIAGRAMS ..... 10 HOURS

A. Diagrams ..... 2 Hours

Outcome: ***Read and interpret electrical drawings and schematic diagrams.***

1. Identify symbols that are commonly used in electrical drawings.
2. Interpret terms used in electrical drawings.
3. Interpret one-line diagrams.
4. Interpret schematic diagrams.
5. Describe the sequence of operation using a schematic diagram.

B. Specifications ..... 4 Hours

Outcome: ***Acquire a working knowledge of specifications.***

1. State the purpose of specifications.
2. Describe the organization of specifications.
3. Extract specific information from specifications.

C. Drawings and Plans ..... 4 Hours

Outcome: ***Read and interpret a set of building drawings.***

1. List and describe the divisions of prints.
2. List and describe the different views and schedules that are typically found in prints.
3. Extract specific information from the prints in general.
4. Extract specific information from a set of prints and drawings.

SECTION FIVE: ..... HEATING AND COOLING CONTROLS ..... 36 HOURS

A. Principles of Automatic Heating and Cooling Controls ..... 8 Hours

Outcome: ***Describe the basic principles for automatic controls for heating and cooling systems.***

1. Outline the basic requirements of heating and cooling systems.
2. Describe the components of a basic forced-air heating system.

3. Interpret basic electrical diagrams used to show the function of a heating or cooling control system.
4. State code requirements relating to the electrical installation of heating and cooling systems.

B. Temperature Sensing and Control Devices ..... 6 Hours

Outcome: Explain the operation of temperature sensing and control devices.

1. Differentiate between the operating characteristics of various temperature-sensing devices.
2. Outline the use and application of various temperature-sensing devices used in heating and cooling systems.
3. Explain how thermostats are used in heating and cooling systems.

C. Basic Gas-Fired Forced-Air Heating Systems ..... 8 Hours

Outcome: Install, maintain, and troubleshoot basic 24 V and 120 V gas-fired, forced-air heating systems.

1. Identify the components used in a basic gas-fired, forced-air heating system.
2. Describe the purpose and application of a thermocouple in a basic gas-fired, forced-air heating system.
3. Confirm proper thermocouple operation including open and closed circuit tests.
4. Describe the operation of a domestic heating system using a 24 V control circuit.
5. Connect a 24V control heating system and observe its operation.
6. Describe the operation of a unit heater using a 120 V control circuit.

D. Mid-Efficiency, Gas-Fired, Forced-Air Heating Systems ..... 4 Hours

Outcome: Explain the operation of, identify the components of and troubleshoot mid-efficiency, gas-fired, forced-air heating systems.

1. Identify the components that make up a mid-efficiency, gas-fired, forced-air heating system.
2. Describe the operation of and troubleshoot a mid-efficiency, gas-fired, forced-air heating system.
3. Describe the purpose of and application of auxiliary equipment used with gas-fired, forced-air heating systems.
4. Observe the operation of a direct spark ignition system and a mid-efficiency gas fired furnace.

E. Basic Hot Water Heating Systems ..... 2 Hours

Outcome: Describe the basic principles for automatic control of heating and cooling systems.

1. Describe the operation of a basic hot water heating system.
2. Identify the purpose and application of the components of a hot water heating system.
3. Analyze and troubleshoot the operation of a hot water heating system.

F. Cooling Systems ..... 4 Hours

Outcome: Explain the operation of and troubleshoot basic cooling systems.

1. Identify the components used in a typical cooling system.
2. Describe the operation of a typical cooling system.
3. Identify the requirements for combining a basic cooling system with an existing forced-air heating system.

4. Observe the operation of a combined heating and cooling systems.

G. HVAC Rooftop Units ..... 4 Hours

Outcome: ***Troubleshoot a basic commercial heating and cooling control circuit for an HVAC unit.***

1. Describe the components of a typical HVAC unit.
2. Describe the operation of a typical HVAC unit.
3. Differentiate between the applications of thermostats.
4. Describe procedures for troubleshooting a rooftop HVAC unit.
5. Observe the operation of a roof top HVAC unit.

SECTION SIX: ..... MAGNETIC CONTROL AND SWITCHING CIRCUITS ..... 40 HOURS

A. Drawings ..... 2 Hours

Outcome: ***Identify and interpret the four basic types of electrical drawings.***

1. Interpret the four basic types of electrical drawings.
2. Interpret the symbols used on schematic drawings and describe the sequence of operation of a control circuit by reading the schematic diagram.

B. Construction of Control Relays and Contactors / Operation of Relays ..... 6 Hours

Outcome: ***Identify and analyze the basic components of a relay or contactor. Describe relay operating characteristics, interpret relay nameplate information and recognize the types of relays that are available.***

1. Identify the three main parts of a relay.
2. Describe the purpose of laminations and shading coils in relays and contactors.
3. Name the three different materials used for constructing relay contacts and identify the applications, advantages and disadvantages of each.
4. Describe the action of electrical contacts when the relay coil is energized and describe the problems that could arise due to incorrect contact spring tension.
5. State the advantages of double break or bridge contacts.
6. Describe the operation of a relay.
7. Interpret nameplate information and relay terminal connections.
8. Recognize and describe several common types of relays.
9. Observe correct relay and contactor operation.

C. Protection Devices (General) / Protective Devices (Motor Circuits) ..... 4 Hours

Outcome: ***Describe the need for and requirements of circuit overcurrent protection. Select control and protective devices for a motor branch circuit.***

1. State two basic requirements of all distribution circuits.
2. Describe two devices used for protecting electrical equipment.
3. Identify the factors that determine short circuit currents.

4. Describe the basic disconnection and control requirements for a motor branch circuit.
5. Describe the two basic protection requirements for a motor branch circuit.
6. List the factors that determine the required ampere rating of control and protective devices in a motor branch circuit.

D. Construction of Magnetic Motor Starters / Overload Devices ..... 6 Hours

Outcome: ***Describe the parts of a magnetic motor starter, understand basic starter selection criteria and recognize basic bench tests that can be performed on a starter.***
Describe, select and set an overload device.

1. Describe the parts of a magnetic motor starter.
2. Describe the criteria for determining the suitability of a starter for a specific application.
3. Recognize the ohmmeter readings that determine the operational condition of a starter.
4. State the reasons for providing overload devices for motors.
5. Summarize the requirements of CEC rules regarding motor overload devices.
6. Describe the operation and types of overload devices used for motor overload protection.

E. Single Motor Control - Part A / Single Motor Control - Part B / Pilot Devices and Symbols ..... 6 Hours

Outcome: ***Describe basic magnetic motor starter control circuits.***
Describe basic types of motor control circuits, list the causes of single-phasing and describe procedures for troubleshooting motor control circuits.
Explain the terms maintained and momentary as they apply to pilot devices and describe the operation of an automatic device.

1. Identify the three sections of a basic stop/start circuit.
2. Describe the behaviour of a control circuit when interlock contacts are placed in each of the three sections.
3. Identify the type of pushbuttons (NO or NC) used for stopping and starting and demonstrate how they would be connected for multiple station operation.
4. Differentiate between low voltage release and low voltage protection and state practical applications for each of the two types of control circuit.
5. List three conditions that could cause the single-phasing of a three-phase motor and demonstrate how a pilot light could be connected to indicate a motor running condition. Determine the cause of a malfunction in a control circuit.
7. Describe the difference between maintained and momentary types of pilot devices and list examples.
8. Describe the basic operation of automatic pilot devices and list examples.
9. Demonstrate the operation of the following single-phase motor controllers.
   a) Single motor control from a single a single station – 2-wire control.
   b) Single motor stop/start control from a single station – 3 wire control.
   c) Single motor control from two stop/start stations.
   d) Demonstrate the operation of float switches used for pilot devices in motor control.

F. Diagram Conversion ..... 6 Hours

Outcome: ***Convert wiring diagrams to schematic diagrams and schematic diagrams to wiring diagrams.***

1. Describe a method by which a wiring diagram may be converted to a schematic diagram.
2. Explain how the electrical sequence of components in a drawing may affect the number of wires in a conduit.

G. Reversing Magnetic Starters ..... 4 Hours

Outcome: ***Describe the operation and components of a reversing magnetic motor starter.***

1. Describe the operation of a reversing magnetic motor starter.
2. State the purpose of the mechanical interlocks on a reversing motor magnetic.
3. State the purpose of the electrical interlocks on a reversing motor magnetic.
4. Identify the terminal numbers for the two sets of holding contacts on a reversing motor magnetic.
5. Identify the seven sections of the control circuit that can be used for the placement of interlock contacts.
6. Demonstrate the operation of the following forward reversing single-phase motor controllers.
   a) *Forward / reverse single station.*
   b) *Forward / reverse push button interlock.*
   c) *Forward / reverse with limit switches.*

H. Transformers ..... 6 Hours

Outcome: ***Describe how and why transformers are used in different applications.***

1. List the basic features and describe the construction of a single winding transformer.
2. Determine the transformation ratio and volts-per-turn value of a single-phase transformer.
3. Describe basic transformer operation.
4. Describe the operation of current limiting (Class 2) transformers.
5. List the internal losses and calculate the efficiency of a transformer.
6. Describe the connection options for a multiple winding transformer.
7. Identify, connect and perform tests on multi-winding transformers.

THIRD PERIOD TECHNICAL TRAINING
ELECTRICIAN TRADE
COURSE OUTLINE

UPON SUCCESSFUL COMPLETION OF THIS PROGRAM THE APPRENTICE SHOULD BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

SECTION ONE: ..... THREE-PHASE PRINCIPLES ..... 78 HOURS

A. Electrical Theory Review ..... 12 Hours

Outcome: ***Review of 1st period theory / series RLC circuits / parallel RLC circuit.***

1. Demonstrate appropriate math skills.
2. Define various electrical terms.
3. State and apply Ohm's law.

B. Series RLC Circuits ..... 2 Hours

Outcome: ***Describe inductive and capacitive reactance and their effects on an AC series circuit.***

1. State and apply basic trigonometric functions.
2. Describe inductive reactance.
3. Describe capacitive reactance.
4. Analyze a series circuit containing a coil and a capacitor.

C. Parallel RLC Circuits ..... 2 Hours

Outcome: ***Analyze a parallel RLC circuit.***

1. State the effects of connecting inductors in parallel.
2. State the effects of connecting capacitors in parallel.
3. Analyze a parallel circuit containing resistance, inductance and capacitance.

D. Three-Phase Systems (General) ..... 4 Hours

Outcome: ***Describe a three-phase electrical system and explain how it is different from a single-phase system.***

1. Explain the difference between single-phase power and three-phase power.
2. Explain the generation of the phase voltages of a three-phase system.
3. Explain the phase sequence of three-phase sine waves.
4. State three main advantages of three-phase power over single-phase power.

E. Three-Phase Systems Wye Connection ..... 30 Hours

Outcome: ***Describe the characteristics of a three-phase wye connection.***

1. State the relationship between phase voltage and line voltage for a wye system.
2. State the relationship between phase current and line current for a wye system.
3. Explain the importance of a neutral conductor on an unbalanced wye system.
4. Draw a complete phasor diagram of a balanced wye-connected circuit.
5. Draw a phasor diagram of a wye circuit with an unbalanced load.
6. Perform calculations for a wye-connected circuit.

F. Three-Phase Systems Delta Connection ..... 28 Hours

Outcome: ***Explain and analyze the relationships between voltages and currents in a delta-connected system.***

1. Explain the relationship between phase voltage and line voltage in a delta-connected system.
2. Explain the relationship between phase current and line current in a balanced delta-connected load.
3. Explain the relationship between phase current and line current in an unbalanced delta-connected load.
4. Perform calculations for a delta-connected circuit.

SECTION TWO:.....THREE-PHASE POWER MEASUREMENT AND POWER FACTOR CORRECTION ..... 22 HOURS

A. Three-Phase Power ..... 6 Hours

Outcome: ***Calculate the power components of three-phase systems, circuits and feeders.***

1. State the mathematical equations for all power components in a balanced three-phase system.
2. State the mathematical equations for all power components in an unbalanced three-phase system.
3. Calculate the three-phase power components in a balanced three-phase system.
4. Calculate the three-phase power components in an unbalanced three-phase system.

B. Three-Wattmeter Connection ..... 4 Hours

Outcome: ***Describe and draw the connections for three-phase metering and calculate meter readings.***

1. Draw a diagram to illustrate the proper connection of three wattmeters in a three-phase circuit.
2. Draw a phasor diagram to determine the readings of each wattmeter in a three-phase circuit.
3. Calculate the readings of each wattmeter in a three-phase circuit.

C. Power Factor Correction ..... 12 Hours

Outcome: ***Explain the reasons for power factor correction and describe the methods of improving power factor for a circuit***

1. Define power factor as it applies to a three-phase system.
2. Explain how capacitors will correct the power factor of a circuit.
3. Determine how capacitors should be connected to a three-phase system for power factor correction.

4. Perform and verify power factor correction calculations.

5. Explain how capacitors can be safely connected to and disconnected from a circuit.

SECTION THREE: ..... THREE-PHASE MOTOR PRINCIPLES ..... 28 HOURS

A. Three-Phase Induction Motors ..... 12 Hours

Outcome: ***Describe the theory of operation of an induction motor.***

1. Identify terms related to a three-phase induction motor and state the principle of operation of a squirrel cage induction motor.
2. Describe the principle of operation of a wound-rotor induction motor.
3. Describe the information located on a motor nameplate.
4. Describe the types of single-speed three-phase motors and controllers.
5. Describe the types of multi-speed three-phase motors and controllers.
6. Identify the leads on a nine lead wye connected motor.
7. Demonstrate the operation of the following three-phase motor controllers.
   a) across the line "full voltage"
   b) manual starters
   c) magnetic starters
   d) primary resistor starter
   e) wye/delta open and close transition starters
   f) auto transformer open and close transition starter
   g) part winding motor and starter
8. Explain the principle of operation of a wound rotor motor.

B. Induction Motor Characteristics ..... 14 Hours

Outcome: ***Describe the characteristics of an induction motor as it starts and runs, and as load is applied to the shaft.***

1. Calculate the synchronous speed and percent slip of a motor.
2. Determine the effect that the percent slip has on rotor parameters.
3. Describe the relationship between torque and rotor electrical characteristics in a squirrel-cage induction motor.
4. Determine a motor's breakdown torque.
5. Calculate motor efficiency, speed regulation and horsepower.
6. Demonstrate the operation of the following multispeed motors and controllers:
   a) Variable torque motor and controller
   b) Constant torque motor and controller
   c) Constant horsepower motor and controller
7. Demonstrate the operation of a variable frequency drive.

C. Phase Converters ..... 2 Hours

Outcome: ***Explain the basic operation of a phase converter.***

1. Explain rotary phase converter operation.
2. Explain static phase converter operation.

SECTION FOUR: ..... TRANSFORMERS ..... 66 HOURS

A. Transformers ..... 6 Hours

Outcome: ***Describe the basic construction and operating features of single-phase transformers.***

1. List the basic features and describe the construction of a single-phase transformer.
2. List transformer cooling methods and describe PCB hazards.

B. Induction, Turns Ratio, Polarity and Multiple Winding ..... 8 Hours

Outcome: ***Analyze and connect multiple-winding transformers using their ratings and polarities.***

1. Calculate the ratings, ratios and associated values of a single-phase transformer.
2. State how transformer voltage taps are used.
3. Describe transformer polarities.
4. Connect a multiple winding transformer.

C. Transformer Load Test ..... 6 Hours

Outcome: ***Explain the term percent voltage regulation and calculate percent voltage regulation values.***

1. Describe transformer action and calculate percent voltage regulation.
2. Perform a load test on a transformer.

D. Transformer Losses, Impedance Voltage and Paralleling ..... 8 Hours

Outcome: ***Perform basic efficiency tests and describe the requirements for paralleling single-phase transformers.***

1. Perform an open-circuit test on a transformer.
2. Perform a short-circuit test on a transformer.
3. Calculate the efficiency and the available short-circuit current of a transformer.
4. Describe the requirements for paralleling single-phase transformers.
5. Describe a Class 2 transformer.

E. Autotransformers ..... 8 Hours

Outcome: ***Analyze the operation of an autotransformer.***

1. Describe the operation of autotransformers.
2. Perform calculations to verify the operation of an autotransformer.
3. List the advantages and disadvantages of autotransformers.

F. Transformer Connections ..... 24 Hours

Outcome: ***Explain the term percent voltage regulation and calculate percent voltage regulation values.***

1. Draw and describe the characteristics of a wye/wye transformer connection.

2. Draw and describe the characteristics of a delta/delta transformer connection.
3. Draw and describe the characteristics of a wye/delta transformer connection.
4. Draw and describe the characteristics of a delta/four-wire delta transformer connection.
5. Draw and describe the characteristics of a delta/wye transformer connection.
6. Draw and describe the characteristics of an open delta/open delta transformer connection.
7. Draw and describe the characteristics of an open wye/open delta transformer connection.

G. Energy Measurement..... 6 Hours

Outcome: ***Explain the requirements for the installation of the equipment required for energy measurement.***

1. Describe the connection of self-contained meter sockets for electrical energy meters.
2. Explain how to read energy and demand meters.
3. Describe the connection and use of instrument transformers.
4. Describe the connection of voltmeter and ammeter transfer switches.
5. Demonstrate how to connect instrument transformers and transfer switches for energy measurement.

SECTION FIVE: ..... CANADIAN ELECTRICAL CODE / NETWORK ..... 46 HOURS
WORKPLACE COACHING SKILLS AND ADVISORY

A. Grounding and Bonding..... 6 Hours

Outcome: ***Interpret and apply the rules and regulations in the CEC that pertain to bonding and grounding.***

1. State the reasons for grounding and define the terms used within Section 10.
2. Apply the appropriate regulations pertaining to bonding and grounding.
3. Determine the required AWG size of conductors for grounding and bonding.

B. Protection and Control ..... 10 Hours

Outcome: ***Describe where protective and control devices must be installed, the common types of devices and how they operate in systems.***

1. Define various terms relating to circuit protection equipment.
2. Describe the construction and operation of various overcurrent devices.
3. Describe the construction and operation of ground fault and arc fault circuit interrupters.
4. Locate and apply the general requirements pertaining to circuit protective devices.
5. Determine when circuit protection and control devices are required.
6. Describe, compare radial, and network distribution systems.
7. Select control devices for applications where they are not required to provide circuit protection.
8. Describe co-ordination and series rating of overcurrent devices.

C. Installation of Equipment ..... 6 Hours

Outcome: Locate and apply the regulations pertaining to the installation of electrical equipment.

1. Locate and apply the regulations pertaining to liquid-filled electrical equipment (indoors and outdoors).
2. Locate and apply the regulations pertaining to the installation of transformers.
3. Locate and apply the regulations pertaining to the installation of fences guarding electrical equipment and electrical equipment vaults.
4. Locate and apply the regulations pertaining to the installation of switchboards, switchgear and panelboards.
5. Locate and apply the regulations pertaining to the installation of submersible pumps.

D. Individual Motors ..... 8 Hours

Outcome: Apply the CEC Section 28 requirements for motor circuits.

1. Define specific terms and describe the CEC general requirements pertaining to the installation of motors.
2. Locate and apply the CEC Rules pertaining to wiring methods, control and disconnecting means for motor circuits.
3. Locate and apply the CEC Rules to determine the type and ampacity of conductors for individual motors.
4. Explain how overload devices operate.
5. Determine the maximum ampere rating of overload devices required for motors.
6. Determine the maximum ampere rating for an overcurrent device required for a motor branch circuit.
7. Perform all the required calculations and select equipment to properly connect an electric motor.

E. Motor Banks ..... 6 Hours

Outcome: Apply the requirements of Section 28 for the design of feeders for groups of motors.

1. Determine the required ampacity of feeder conductors for a group of motors.
2. Determine the maximum allowable ampere rating of an overcurrent device for a group of motors.
3. Perform the required calculations and select equipment to properly connect a group of motors.

F. Sections 68, 70 and 72 ..... 6 Hours

Outcome: Identify and interpret electrical installation regulations concerning pools and spas, mobile home parks and recreational vehicle parks, and temporary wiring.

1. Locate and apply the regulations pertaining to the installation of electric wiring in or adjacent to swimming pools.
2. Locate and apply the regulations pertaining to the services and distribution facilities of mobile homes and recreational vehicle parks.
3. Locate and apply the regulations pertaining to temporary wiring installations.

G. Workplace Coaching Skills and Advisory Network ..... 4 Hours

Outcome:

1. Describe the following coaching skills used for training apprentices:
   a) identify the point of the lesson
   b) link the lesson

c) demonstrate a skill
d) provide opportunity to practice a skill
e) give feedback to learner
f) assess the learner's progress

2. Describe the role and purpose of the advisory network and the Provincial Apprenticeship Committee for the Electrician trade.

FOURTH PERIOD TECHNICAL TRAINING
ELECTRICIAN TRADE
COURSE OUTLINE

UPON SUCCESSFUL COMPLETION OF THIS PROGRAM THE APPRENTICE SHOULD BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

SECTION ONE: ..... ELECTRICAL THEORY REVIEW ..... 10 HOURS

A. Basic Electrical Circuits ..... 2 Hours

Outcome: ***Describe and analyze basic resistive electrical circuits.***

1. Demonstrate the math skills required to analyze basic electrical circuits.
2. Define various electrical terms.
3. Describe and analyze series and parallel resistive circuits.

B. Series RLC Circuits ..... 2 Hours

Outcome: ***Describe inductive and capacitive reactance and their effects on an AC series circuit.***

1. State and apply basic trigonometric functions.
2. Describe inductive reactance.
3. Describe capacitive reactance.
4. Analyze a series circuit containing a coil and a capacitor.

C. Parallel RLC Circuits ..... 2 Hours

Outcome: ***Analyze a parallel RLC circuit.***

1. State the effects of connecting inductors in parallel.
2. State the effects of connecting capacitors in parallel.
3. Analyze a parallel circuit containing resistance, inductance and capacitance.

D. Three-Phase Basics ..... 4 Hours

Outcome: ***Complete calculations for three-phase wye and delta loads.***

1. Complete calculations for a wye-connected circuit.
2. Complete calculations for a delta-connected circuit.
3. Calculate the three-phase power components in a balanced three-phase system.
4. Calculate the three-phase power components in an unbalanced three-phase system.

SECTION TWO: ..... DC MACHINES ..... 44 HOURS

A. Direct Current Machines ..... 6 Hours

Outcome: Describe the main parts of a DC machine and interpret DC machine nameplate information.

1. Define and explain general terms used to describe DC machines.
2. Describe the parts of a DC machine.
3. Describe specified DC machine nameplate information.

B. Direct Current Generator Principles ..... 10 Hours

Outcome: Describe the principles of operation of a DC generator.

1. Describe the factors related to the establishment of a magnetic field within a DC generator.
2. Describe the process through which a voltage is generated in a generator.
3. Describe armature reaction.
4. Describe voltage regulation in a DC generator.
5. Describe motor action in a DC generator.

C. Types of Direct Current Generators ..... 8 Hours

Outcome: Identify the types of DC generators and describe their operating characteristics.

1. Describe the different methods of field excitation of DC generators.
2. Describe the external characteristics of voltage regulation for separately excited generators.
3. Describe the external characteristics of voltage regulation for self-excited generators.
4. Demonstrate the operation of the following DC generators:
   a) separately-excited shunt generator.
   b) self-excited shunt generator.
   c) series generator
   d) cumulative compound generator :
   e) differential compound generator.

D. Types of Direct Current Motors (Part I) ..... 10 Hours

Outcome: Describe how a DC motor operates.

1. Describe the principle of operation of DC motors.
2. State the relationship between torque, field intensity and armature current in a DC motor.
3. Describe generator action in DC motors.
4. Describe the effects of armature reaction.
5. Describe the factors that affect motor speed and define the terms relating to base speed.

E. Types of Direct Current Motors (Part II) ..... 10 Hours

Outcome: ***Describe the effects of loading on various DC motors, the types of starting methods used and how dynamic braking works.***

1. Describe the effects of load on different types of DC motors.
2. Describe the different methods used to start DC motors.
3. Explain the principle of dynamic braking.

SECTION THREE: .....ALTERNATING CURRENT (AC) MACHINES..... 38 HOURS

A. Three-Phase Alternators ..... 8 Hours

Outcome: ***Describe the basic construction and theory of operation of a three-phase alternator.***

1. State the basic principles of operation of alternators.
2. Identify the reasons for using rotating fields and describe two distinct types of rotors.
3. Describe the construction and electrical connections of a stator.
4. Describe how the rotor field is excited and how the output voltage is controlled.
5. Describe synchronous impedance and the way it affects terminal voltage.
6. Describe how a load test and an impedance test are performed.
7. Identify alternator losses.

B. Paralleling Alternators ..... 6 Hours

Outcome: ***Describe how to synchronize and parallel two alternators, and shift a load to an incoming alternator.***

1. Describe how to synchronize and parallel alternators.
2. Describe the method of shifting or sharing load between alternators.

C. Synchronous Motors (Part I) ..... 6 Hours

Outcome: ***Describe the basic operation of a synchronous motor.***

1. List the components of a synchronous motor and compare them to the parts of an induction motor.
2. Explain the principle of operation of a synchronous motor.
3. Explain the relationship between field excitation, stator voltage, stator impedance and stator current.
4. Describe the procedure used to start synchronous motors.

D. Synchronous Motors (Part II) ..... 6 Hours

Outcome: ***Describe the effects of changing load or excitation on a synchronous motor and interpret a synchronous motor nameplate.***

1. Explain the effects of varying the load on power factor, torque angle and current.
2. Explain the effects of varying the field excitation on power factor, torque angle and current.
3. Determine how synchronous motors are used to drive mechanical loads and correct power factor.

4. Interpret the nameplate data of a synchronous motor and list some typical applications.

E. Single-Phase Motors (Part I) ..... 6 Hours

Outcome: ***Describe the principles of operation, types and applications of split-phase, single-phase motors.***

1. Describe the components, principles of operation and applications of a resistance split-phase motor.
2. Describe the components, principles of operation and applications of a capacitor-start motor.
3. Describe the components, principle of operation and applications of a permanent-split-capacitor motor.
4. Describe the components, principle of operation and applications of a two-value capacitor motor.
5. Demonstrate the operation of the following single-phase motors.
   a) dual voltage motor
   b) resistance start motor
   c) capacitor start motor
   d) permanent capacitor motor
   e) shaded pole motor

F. Single-Phase Motors (Part II) ..... 6 Hours

Outcome: ***Describe the operation of shaded-pole and series AC single-phase motors; interpret connection diagrams for various split-phase motors and complete single-phase motor performance calculations.***

1. Describe a shaded-pole induction motor.
2. Describe a series AC motor.
3. Draw typical connection diagrams for single-phase motors.
4. Calculate synchronous speed (rotational frequency), % slip, speed regulation, horsepower and torque.

SECTION FOUR: ..... CONTROL AND SWITCHING / PLC ..... 50 HOURS

A. Drawings and Basic Circuits ..... 6 Hours

Outcome: ***Describe the types of electrical drawings and interpret a basic motor control circuit.***

1. Identify symbols used in electrical drawings.
2. Recognize four types of electrical drawings and identify the primary purpose of each.
3. Demonstrate the ability to interpret schematic diagrams to understand how basic stop/start control and electrical interlock circuits operate in a motor-control circuit.

B. Controls and Switching Circuits (General) ..... 6 Hours

Outcome: ***Utilize various control elements (such as selectors and limits) to control three-phase motors (including reversing, jogging and inching).***

1. State the elements involved in the forward/reverse stop control of three-phase motors.
2. State the meaning of the terms jogging and inching and describe their circuit designs.
3. Develop schematic diagrams for circuits using selector switches and pilot lights.
4. Develop schematic diagrams for circuits using limit switches and pressure switches.

C. Special Control Circuits ..... 6 Hours

Outcome: ***Describe the application of timing devices, motor braking, plugging and anti-plugging.***

1. Describe timers and basic timing functions.
2. Explain the reason for and the operation and application of motor braking.
3. Describe plugging and anti-plugging as they apply to electric motors.
4. Demonstrate the operation of the following Three-Phase motor controllers:
   - a) forward reversing magnetic starter :
   - b) forward reversing with stop button :
   - c) forward reversing with direct direction switch :
   - d) jogging circuit with three button control :
   - e) jogging button using selector switch :
   - f) jogging control using control relay :
   - g) forward reversing using jogging :
   - h) hand / off / auto selector switch :
   - i) forward / reversing with limit switches
   - j) motor control using float switches.
   - k) motor control using pressure switches.
   - l) motor control using time delay.
   - m) motor control using plugging switch.

D. Diagram Conversion ..... 6 Hours

Outcome: ***Convert wiring diagrams to schematic diagrams and schematic diagrams to wiring diagrams.***

1. Describe the conversion of wiring diagrams to schematic diagrams.
2. Describe the conversion of schematic diagrams to wiring diagrams and explain how the sequence of component connections can affect the wiring installation.

E. Introduction to Programmable Logic Controllers ..... 26 Hours

Outcome: ***Describe the function and hardware components common to Programmable Logic Controllers (PLC).***

1. Describe the function of programmable logic controllers.
2. Describe PLC hardware components.
3. Describe five types of PLC programming.

SECTION FIVE: ..... FIRE ALARM SYSTEMS ..... 30 HOURS

A. Fire Detection and Alarm Systems ..... 6 Hours

Outcome: ***Describe the general principles and components of a fire alarm system.***

1. Explain the general principles of fire detection and alarm systems.
2. Describe fire system detection devices.
3. Describe fire system signalling devices.
4. Describe fire system ancillary equipment.
5. Explain the operation of a smoke alarm.

B. Fire Detection and Alarm System Regulations ..... 6 Hours

Outcome: ***Identify and describe fire detection and alarm system regulations.***

1. Describe the areas of jurisdiction of the governing authorities for fire system codes and standards.
2. Identify the requirements for the installation, verification, audits and maintenance of a fire alarm system.

C. Fire Alarm System Occupancy Classifications ..... 6 Hours

Outcome: ***Determine the criteria for the installation of a fire alarm system and for the location of its components.***

1. Determine when a fire alarm system is required for a specific occupancy.
2. Determine the type and location of fire alarm components for a specific occupancy.

D. Wiring Procedures for Fire Alarm Systems ..... 12 Hours

Outcome: ***When you have completed this module you will be able to describe wiring methods and procedures for fire alarm systems.***

1. Describe fire alarm system wiring methods and restrictions as contained in the Canadian Electrical Code, Part I, 19th Edition.
2. Describe power and emergency power supply requirements for fire alarm systems.
3. Identify and draw fire alarm circuits for specific systems.
4. Determine the number of conductors required in a cable or conduit run at any given location within a fire alarm system.

SECTION SIX: ..... ELECTRONICS / DIODES / RECTIFIERS ..... 38 HOURS

A. Electrical Properties and Measuring Instruments ..... 18 Hours

Outcome: ***Recall the characteristics of fundamental electronic circuit components and properly use measuring instruments.***

1. Explain the different ways of defining voltage and current values.
2. Explain the electrical properties and ratings of resistors.
3. Explain the electrical properties and ratings of capacitors.
4. Explain the electrical properties and ratings of inductors.
5. Use test equipment to measure the electrical characteristics of component and circuit properties.

B. Diodes and Rectifier Circuits ..... 10 Hours

Outcome: ***Describe the principles of operation and the applications of diodes in rectifier circuits.***

1. Explain the operating characteristics of diodes.
2. Describe the principles of operation of single-phase rectifiers.
3. Describe the principles of operation of three-phase rectifiers.
4. Describe the effects of adding filters to a rectifier circuit.
5. Demonstrate the connection of diodes as used in rectifier circuits.

6. Describe and demonstrate the effects of adding filters to a rectifier circuit.

C. Application of Diodes and Rectifiers ..... 10 Hours

Outcome: ***Identify, test and replace the rectifier components in a battery charger and welder.***

1. Select replacement rectifier components including diodes, heat sinks and filter capacitors from manufacturer's specification sheets.
2. Describe the operation of and troubleshoot the rectifier stage of a battery charger.
3. Describe the operation of and troubleshoot the rectifier stage of a welder.
4. Describe the practical aspects and typical applications of diodes.

SECTION SEVEN: ..... ELECTRONICS / POWER / SWITCHING ..... 30 HOURS

A. Transistors and Photo Devices ..... 10 Hours

Outcome: ***Identify, test and state applications for bipolar junction transistors, field effect transistors, insulated gate bipolar transistors and various photo devices.***

1. Describe the principles of operation and applications of the bipolar junction transistor.
2. Describe the principle of operation and applications of the field effect transistor.
3. Describe the principle of operation and applications of the insulated gate bipolar junction transistor.
4. Describe the principle of operation and applications of various photoelectronic devices.
5. Demonstrate the ability to test the bipolar junction transistor.
6. Demonstrate the connection of a bipolar junction transistor as a current control device.

B. Thyristors ..... 10 Hours

Outcome: ***Describe the principles of operation and typical applications of common thyristor devices.***

1. Describe the principle of operation and application of an SCR (silicon controlled rectifier).
2. Describe the principle of operation and application of an SCR firing circuit.
3. Describe the principle of operation and application of a Triac.
4. Analyze a circuit application using a Triac to control a resistive lighting load.

C. Practical Applications of Thyristor Circuits ..... 10 Hours

Outcome: ***Analyze the operation of and troubleshoot the thyristor stages of typical industrial applications.***

1. Connect and troubleshoot a circuit that uses an SCR to control a DC motor from a single-phase supply.
2. Troubleshoot a circuit that includes an SCR used to control a DC motor from a three-phase supply.
3. Troubleshoot a circuit that includes an SCR used in a battery charger circuit.
4. Connect and troubleshoot a circuit of a triac used in motor control circuits.

SECTION EIGHT: .....ELECTRONICS / APPLICATIONS ..... 30 HOURS

A. Voltage Regulators ..... 8 Hours

Outcome: ***Describe how voltage regulators control the output or terminal voltage of a generator while operating at varying loads.***

1. Describe the operation of a shunt regulator.
2. Describe the operation of direct current machine voltage regulators.
3. Describe the operation of a commercial alternator voltage regulator.

B. Uninterruptible Power Supply Systems ..... 10 Hours

Outcome: ***Explain the operation of, and be able to maintain and troubleshoot common uninterruptible power supply systems.***

1. Describe the principles of operation and applications of a UPS system.
2. Explain the operation of an inverter circuit.
3. Describe the installation of a UPS system.
4. Troubleshoot and maintain a UPS system.

C. Variable Frequency Drives ..... 12 Hours

Outcome: ***Install, program, adjust and troubleshoot variable frequency drives in typical industrial applications.***

1. Recall the principles of operation of AC induction motors.
2. Compare methods of speed control of AC induction motors.
3. Describe the principles of operation and application of a typical variable frequency drive.
4. Troubleshoot and maintain a VFD.

SECTION NINE:.....CANADIAN ELECTRICAL CODE PART I APPLICATIONS..... 36 HOURS

A. Conductors ..... 4 Hours

Outcome: ***Determine the size and ampacity of all power and lighting circuit conductors by taking the following conditions into consideration: the degree of enclosure, the ambient temperature, the type of insulation and the conditions of use.***

1. Determine the allowable ampacity and AWG size of circuit conductors.
2. Determine the allowable ampacity and AWG size of neutral conductors.
3. Determine the minimum size of conduit required for installations.
4. Apply the CEC Rules for voltage drop.

B. Protection, Control and Wiring Methods ..... 6 Hours

Outcome: ***Describe the requirements for selecting overcurrent devices, ground fault devices, junction and pull boxes, and the need for expansion joints.***

1. Determine the points in a circuit where overcurrent devices are required.

2. Determine when ground fault protection for equipment is required.
3. Select the proper type and rating of overcurrent devices.
4. Describe the control devices required for conductors and equipment.
5. Determine the minimum dimensions and volume of pull boxes, junction boxes and outlet boxes.
6. Determine when conduit expansion must be taken into consideration and calculate conduit expansion.

C. Grounding, Bonding and Distribution Layout ..... 4 Hours

Outcome: ***Interpret and apply the relevant CEC regulations regarding grounding, bonding and electrical service and distribution installations.***

1. List the reasons for grounding and bonding.
2. Apply the CEC regulations with respect to system and circuit grounding and bonding.
3. Apply the CEC regulations with respect to equipment bonding.
4. Lay out an electrical distribution centre.

D. Electric Welders ..... 8 Hours

Outcome: ***Describe the requirements for electric welder installations.***

1. Determine the minimum allowable ampacity of conductors, the maximum rating of overcurrent devices and the rating of the disconnect means for one or more transformer arc welders.
2. Determine the minimum allowable ampacity of conductors, the maximum rating of overcurrent devices, and the rating of the overload devices for one or more motor-generator arc welders.
3. Determine the minimum allowable ampacity of conductors, the maximum rating of overcurrent devices, and the rating of the disconnect means for one or more electric resistance welders.

E. Installation of Capacitors and Transformers ..... 4 Hours

Outcome: ***Select and install the conductors and control devices for a capacitor or transformer according to the requirements of the CEC.***

1. Select appropriate locations for liquid-filled capacitors and transformers according to CEC rules.
2. Calculate the kvar rating of capacitors required to improve or correct the power factor of an inductive load.
3. Calculate the rating or setting of the motor overload device in circuits where power factor correction capacitors are used on the load side of a motor controller.
4. Determine the minimum allowable ampacity of conductors, the rating of disconnect switches and the maximum rating of overcurrent devices for capacitor circuits.
5. Determine the minimum allowable primary and secondary conductor ampacity and the maximum rating of overcurrent devices for transformers.

F. Hazardous and Special Locations ..... 6 Hours

Outcome: ***Identify locations within areas or premises that may be hazardous or Category 1 or 2 locations and describe the acceptable equipment and wiring methods to be used.***

1. Describe the hazardous locations and the way they are classified in Section 18.
2. Identify the equipment and wiring methods required for each of the hazardous location classifications.

3. Identify the areas containing hazardous locations as outlined in Section 20 and describe the requirements for electrical installations in each area.

4. Identify Section 22 locations and select acceptable equipment and wiring methods for these locations.

G. Individual Motors and Motor Banks ..... 4 Hours

Outcome: ***Determine the minimum required conductor ampacity, maximum overcurrent device ratings and maximum overload device ratings or settings for individual motors and motor banks.***

1. Describe the CEC general requirements for the installation of a motor.
2. Determine the type, minimum allowable ampacity and AWG size for motor conductors.
3. Determine the rating of overcurrent and overload devices required for a motor branch circuit.
4. Determine the minimum allowable ampacity and AWG size of feeder conductors required for a group of motors.
5. Determine the minimum ampacity of the feeder overcurrent device required for a group of motors.
6. Apply the CEC regulations to properly connect a group of motors.

SECTION TEN: ..... CANADIAN ELECTRICAL CODE PART I CALCULATIONS ..... 36 HOURS

A. Service Feeder and Branch Circuit Requirements for a Single Dwelling ..... 6 Hours

Outcome: ***Describe the requirements for single dwelling feeder and branch circuits.***

1. Define specific terms from Section 8.
2. Determine the minimum allowable ampacity and size of service or feeder conductors supplying a single dwelling.
3. Determine the minimum number of branch circuit positions for a panelboard.
4. Determine the minimum allowable ampacity of branch circuit conductors and the ampere ratings of overcurrent devices for circuits in a single dwelling.
5. Determine the minimum number and location of electrical outlets in a single dwelling.
6. Determine where ground fault and arc fault circuit interrupters are required in a single dwelling.

B. Electrical Requirements for Apartments and Similar Buildings ..... 8 Hours

Outcome: ***Determine***
a) The loading on services, feeders and branch circuits for apartments and similar buildings and calculate the minimum required ampacity of these conductors.
b) the minimum number and location of electrical outlets, along with the number of special or general branch circuits needed to supply them from the house and parking lot panel feeders in apartments and similar buildings.
c) the requirements for service conduit sizing and service equipment grounding and bonding.
d) the CEC requirements for electric discharge lighting systems, fire alarm systems, emergency systems, unit equipment and exit signs.

1. Calculate the minimum allowable ampacity for feeders to individual dwellings of an apartment complex or similar building.
2. Determine the demand load on a feeder for a panelboard supplying loads not located in dwelling units.
3. Determine the demand load on a parking lot panelboard feeder.
4. Calculate the minimum allowable ampacity for the main service to an apartment complex.
5. Determine the size of conduit required when dealing with conductors of different AWG sizes.

6. Determine the requirements for service equipment grounding and bonding.
7. Apply the CEC requirements for Electric-Discharge Lighting Systems.
8. Apply the CEC requirements for Fire Alarm Systems.
9. Apply the CEC requirements for Emergency Systems, Unit Equipment and Exit Signs.

C. Schools, Hospitals and Hotels/Motels ..... 8 Hours

Outcome: Calculate the service requirements for schools, hospitals, hotels and motels.

1. Determine the requirements for a service for a school not larger than 900 square metres.
2. Determine the requirements for a service for a school larger than 900 square metres
3. Determine the requirements for a service for a hospital not larger than 900 square metres.
4. Determine the requirements for a service for a hospital larger than 900 square metres.
5. Determine the requirements for a service for a hotel/motel not larger than 900 square metres.
6. Determine the requirements for a service for a hotel/motel larger than 900 square metres.

D. Other Occupancies ..... 10 Hours

Outcome: Apply CEC Rule 8-210 and Table 14 to determine service and feeder requirements for occupancies not covered by Rules 8-200 through 8-208. These installations are known as other types of occupancy.

1. Determine the requirements for a service or feeder for an office where the total area does not exceed 930 square metres.
2. Determine the requirements for a service or feeder for an office where total area exceeds 930 square metres.
3. Determine the requirements for a service for a store.
4. Determine the requirements for a service for a warehouse containing motor loads and various other loads.

E. High-Voltage Installations ..... 4 Hours

Outcome: Describe and discuss safe installation and operating procedures for high-voltage installations.

1. Identify the components of high-voltage cable and state the purpose of each.
2. Use high-voltage cable terminology to describe the theory of electrical stress control for high-voltage cables.
3. Describe how high-voltage cables are spliced and terminated.
4. Interpret the safety regulations pertaining to the installation of high-voltage cables.

SECTION ELEVEN: .....CANADIAN ELECTRICAL CODE PART I LIGHTING ..... 18 HOURS

A. Lighting ..... 8 Hours

Outcome: Select, install and maintain lighting fixtures based upon the user's lighting needs.

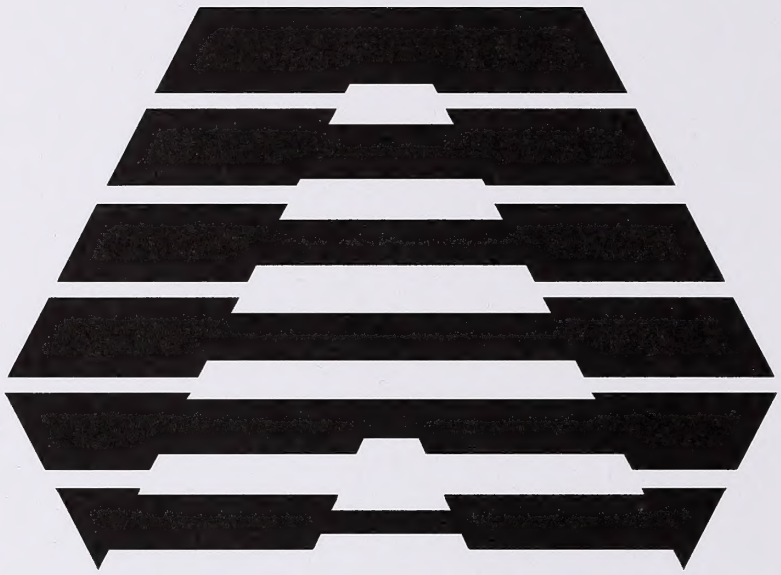
1. Define specific terms that are used in the lighting industry.
2. Describe the different types of electric lighting sources.
3. Describe the theory of operation of fluorescent and HID lamps.

4. Describe the types, purpose and basic operation of ballasts for electric discharge lighting lamps.
5. Compare the efficiencies and light outputs of various light sources.
6. Describe the restrictions on lamp interchangeability and the advantages and disadvantages of different maintenance regimes.
7. Calculate the approximate number of fixtures required for illuminating a specified room to a specified lighting level.

B. Data Cabling ..... 10 Hours

Outcome: ***Explain installation considerations and troubleshooting for data cabling systems in residential and commercial buildings.***

1. Describe the basic considerations for data cable installations.
2. Differentiate between data cable types and characteristics.
3. Describe typical data cabling system topographies and characteristics.
4. Describe installation practices for copper data cabling.
5. Describe installation practices for optical fibre cabling.
6. Explain procedures for testing and troubleshooting data cabling installations.



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